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U.S. Congress
Washington, DC 20515

Douglas Holtz-Eakin, Director

March 18, 2005

Honorable Ike Skelton
Ranking Member
Committee on Armed Services
U.S. House of Representatives
Washington, DC 20515-6035

Dear Congressman:

In response to your request, the Congressional Budget Office (CBO) has assessed the types of major equipment under stress from ongoing military operations in Iraq and Afghanistan and estimated the potential costs associated with rectifying problems resulting from excessive wear and tear.

CBO estimates costs for 2005 of roughly \$8 billion to rectify wear and tear. CBO also notes that operations in 2003 and 2004 caused damage to equipment that had not been corrected by the beginning of 2005. Including that backlog brings the potential total costs of repairing and replacing damaged equipment in 2005 to between \$13 billion and \$18 billion. The bulk of those costs—roughly 60 percent—are attributable to lost and worn-out Army equipment. The Navy's requirements are the smallest—less than 5 percent of the total costs. The Air Force and Marine Corps account for 20 percent and 15 percent, respectively, of those costs. If either the size of the forces maintained in Iraq and Afghanistan or the pace of operations conducted there decreases appreciably, the costs resulting from worn-out equipment will also decline.

The enclosure describes the analysis by CBO's National Security Division. If you would like further details, we would be pleased to provide them. The analysis was prepared by Daniel Frisk, who can be reached at (202) 226-2761, and by Frances Lussier, who can be reached at (202) 226-2906.

Sincerely,

Douglas Holtz-Eakin

Enclosure

cc: Honorable Duncan Hunter
Chairman

The Potential Costs Resulting from Increased Usage of Military Equipment in Ongoing Operations

March 18, 2005

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Unless otherwise indicated, all dollar figures in this analysis are in 2005 dollars, and all years referred to are federal fiscal years, which run from October 1 to September 30.

Numbers in the text and tables may not add up to totals because of rounding.

Contents

Summary	1
Introduction	3
Data Requirements	3
CBO's Approach	4
A Top-Down Approach to Estimating the Cost of Wear on Military Equipment in Ongoing Operations	6
Current Levels of Equipment Stress	9
Changes in Equipment Costs over Time	15
A Bottom-Up Approach to Estimating the Cost of Wear on Equipment	18
Army Requirements	21
Marine Corps Requirements	24
Air Force Requirements	25
Navy Requirements	26
Accumulated and Future Requirements Related to Equipment Stress and Loss	28
Service Estimates of Funding Required to Address Equipment Stress	28
Comparison of CBO's Estimates and Those of the Services	30
How CBO's Estimates Differ from Each Other	30
How CBO's Estimates Differ from Those of the Services	32

Tables

S-1.	CBO and Service Estimates of Costs Related to Equipment Stress and Loss	2
1.	Army Equipment Use In-Theater in 2005	10
2.	Marine Corps Equipment Use In-Theater in 2005	12
3.	Air Force Aircraft Use in Ongoing Operations in 2005	13
4.	Navy Aircraft Use in Ongoing Operations in 2005	14
5.	Estimated Total Cost to Replace and Refurbish the Services' Equipment in 2005	15
6.	Costs and Funds Appropriated for Equipment Stress and Loss, 2003 to 2005	17
7.	The Basis for Estimating Costs for Each Activity Using the "Bottom-Up" Approach	23
8.	Army Maintenance and Replacement Costs Resulting from Operations in 2005	24
9.	Marine Corps Maintenance and Replacement Costs Resulting from Operations in 2005	26
10.	Air Force Maintenance and Replacement Costs Resulting from Operations in 2005	27
11.	Navy Maintenance and Replacement Costs Resulting from Operations in 2005	28
12.	Service Estimates of Unpaid Costs Accrued Through 2005 to Replace and Refurbish Equipment Used in the War on Terrorism Since 2003	30
13.	CBO's Estimates of Costs for 2005 and Total Unpaid Costs Accrued Through 2005 Related to Equipment Stress and Loss	31
14.	Comparison of CBO's Approaches to Estimating Costs Associated with Equipment Stress	32

Figures

1.	Illustrative Relationship Between Vehicle Usage, Age, and Lifetime	7
2.	Assumed Reductions in Forces and Operating Tempo from the 2005 Level	18
3.	Annual Funds Needed to Replace Equipment Lost Because of Stress and Damage in Contingency Operations, Based on CBO's Top-Down Approach	19
4.	Maintenance and Replacement Activities	21
5.	Examples of Peacetime Relationship Between Annual Flying Hours and Total Maintenance Spending	22
6.	Annual Funds Needed to Maintain and Replace Equipment Used in Contingency Operations, Based on CBO's Bottom-Up Analysis	29

Box

1.	Maintenance and Replacement Activities	21
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Summary

The United States has maintained substantial military forces in Iraq and Afghanistan operating at relatively high rates since hostilities began in Iraq in March 2003. As a consequence, the services are discovering that many of the hundreds of thousands of pieces of equipment that have been used in operations in Iraq and Afghanistan are in need of replacement or repair. At the request of the Ranking Member of the House Committee on Armed Services, the Congressional Budget Office (CBO) attempted to determine the number and types of equipment being used by the military services at higher-than-normal levels in Iraq and Afghanistan and to estimate the potential resource implications of the resulting need to repair or replace significant portions of that equipment.

On the basis of information from the services, CBO ascertained that Army and Marine Corps equipment in-theater is, in general, being used at rates that are many times greater than those typical of peacetime. In particular, trucks from those two services are being driven roughly 10 times more miles per year than has been the average over the past several years. The Army's and Marine Corps' combat vehicles—such as tanks and light armored vehicles—are being driven at rates roughly five times those of peacetime. Finally, those two services' helicopters are being flown at roughly twice peacetime rates.

In contrast, the effect of operations in Iraq and Afghanistan on the Navy's and Air Force's assets is much less dramatic than on those of the Army and Marine Corps. CBO found that the greatest increase in activity could be attributed to the Navy's ships stationed in the Iraqi theater, which have been steaming roughly 40 percent more days per year as they would in peacetime. In general, increases in operating tempo were much smaller for most Air Force and Navy fixed-wing aircraft.

CBO used two methods to estimate the additional cost that would accrue from the increased usage of the services' equipment compared with the normal peacetime cost. Those two methods—one a "top-down" and the other a "bottom-up" approach—yielded roughly comparable estimates of the annual costs to replace or repair worn equipment (see Summary Table 1). All told, CBO estimates that the cost from wear and tear on equipment resulting from operations in 2005 could be on the order of \$8 billion.

Some of the problems with worn-out equipment that the services are now just beginning to address are the result of operations in previous years. Activity in the Iraqi theater began in earnest in mid-2003 and has continued at a relatively high pace to the present. Thus, in addition to bills for activity in 2005 that will come due at the end of the year, costs have accrued for repairs and replacements stemming from operations in the second half of 2003 and all of 2004. The services have received funds to cover some of the costs resulting from activity in 2003, 2004, and 2005, but not enough to cover all of the costs. CBO calculates, on the basis of its estimates and funding pro-

Summary Table 1.**CBO and Service Estimates of Costs Related to Equipment Stress and Loss**

(Billions of dollars)

	CBO "Top-Down" Method		CBO "Bottom-Up" Method ^a		Service Estimate of Unpaid Accrued Costs
	2005 Only	Unpaid Costs Accrued Through 2005	2005 Only	Unpaid Costs Accrued Through 2005	
Army	5.3	11.6	4.5	7.9	9.2
Marine Corps	1.1	2.7	1.1	2.2	1.7
Air Force	1.8 ^b	3.9 ^b	1.5	2.8	0.9
Navy	n.a.	n.a.	0.3	0.3	1.0
Navy aviation	0.2	0.2	0.1	0.1	0.4
Total	8.4	18.4	7.4	13.2	12.8

Source: Congressional Budget Office.

Note: n.a.= not applicable.

a. Based on midpoint of range of estimates.

b. Average of estimates based on aircraft lifetime of 30 years to 40 years.

vided to the services that it can identify in supplemental appropriations enacted in 2003 and 2004, that the services will have a collective backlog of expenses in 2005 of \$13 billion to \$18 billion resulting from equipment stress and loss. More than half of those costs are attributable to wear on Army equipment, with the Marine Corps and the Air Force accounting for most of the remaining costs.

The services also developed, at the request of the Secretary of Defense, their own estimates of the total funds required to correct equipment problems that accumulated through usage in the war on terrorism, which includes operations in Iraq and Afghanistan. The Army's and the Marine Corps' estimates are generally comparable with CBO's (see Summary Table 1). In contrast, CBO's estimates for Air Force requirements are appreciably higher than the service's estimate. And with regard to total unpaid costs associated with Navy equipment, CBO's estimate is on the order of \$400 million, whereas the Navy's estimate is significantly higher at \$1 billion.

The supplemental funding request submitted by the Administration in February 2005 included funds to address the services' equipment-stress problem. The narrative accompanying the supplemental request indicates that \$12 billion is included to "recapitalize equipment, conduct depot maintenance, and procure new and replace-

ment equipment.” That requested amount correlates well with the services’ estimates of their accrued costs.

CBO estimates that once the backlog of accumulated maintenance, repair, and replacement requirements has been met, the annual funding needed to address the costs of wear to equipment should drop. As long as forces and operations are maintained at the 2005 level, annual funding of about \$8 billion will be needed. But if the pace of operations and level of forces gradually decrease to roughly 20 percent of current levels, then annual funding requirements could also drop to somewhat less than \$1 billion.

Introduction

The United States continues to maintain substantial forces in Iraq and Afghanistan in pursuit of the war on terrorism. As a consequence of the duration of the deployment and the pace of activity in those countries, the military services are becoming increasingly concerned about the effects that those sustained operations are having on their equipment. The supplemental appropriations for 2004 approved by the Congress included substantial funds for maintenance and repair of equipment worn or damaged in Iraq and Afghanistan, and the recently submitted request for supplemental funds for 2005 includes additional amounts to repair and replace worn-out or damaged equipment.

The Ranking Member of the House Armed Services Committee asked the Congressional Budget Office to provide the committee with an assessment of the magnitude of the problem—regarding both the numbers of systems affected and budgetary implications—of stress and wear on the military services’ equipment resulting from operations in Iraq and Afghanistan. Specifically, the committee asked CBO to determine the types and amount of equipment being used at high rates in operations overseas. The committee also requested that CBO determine the potential resource implications of the increased need for equipment repair and replacement caused by potential reductions in the remaining operational lifetime of the affected equipment.

Data Requirements

To fully answer the committee’s request, CBO would need extensive and detailed information concerning the services’ equipment and its usage in both peacetime and current operations related to the war on terrorism.¹ Those data include:

1. Although the committee’s request referred specifically only to operations in Iraq and Afghanistan, CBO considered the effect of all operations that are part of the war on terrorism on the services’ equipment. In addition to Operation Iraqi Freedom, which accounts for most operations that are stressing the services’ equipment, both Operation Enduring Freedom in Afghanistan and Operation Noble Eagle (which includes operations in the United States) also contribute to the services’ increased pace of operations and corresponding equipment use.

- The peacetime operating tempo (OPTEMPO) for each piece of equipment and associated funds provided in peacetime for spare parts and maintenance activity to support that level of usage, to determine the amount of additional funding needed because of increased usage;²
- The number and type of equipment in-theater as well as the rate at which it is being used; and
- The nominal operating lifetime that the services assume for their equipment, to determine the impact of increased or accelerated aging of specific pieces of equipment when they are used at very high rates in the Iraqi and Afghani theaters.

In attempting to answer the committee's request, CBO was not able to gather data that were consistent among the services and complete in all areas. In the case of the Army, CBO was unable to determine the specific number and type of equipment in-theater in 2004 or the usage rates for each type of Army equipment. The Marine Corps, in contrast, provided CBO with information concerning quantities, usage rates, or both for most of the roughly 100 types of its equipment in use in Iraq. The Navy provided CBO with some information on the number and types of aircraft in-theater and their usage rates, as well as general information concerning ships involved in Operation Iraqi Freedom (OIF) in Iraq and Operation Enduring Freedom (OEF) in Afghanistan. The Air Force did not provide CBO with detailed data on the quantity and operating tempo of its equipment in the Iraqi and Afghani theaters.³

CBO's Approach

The variation among the services in level of forces in-theater and in the quality and quantity of data regarding those forces led CBO to treat the analysis of each service's equipment separately. Moreover, CBO used two different methods to attempt to gauge the magnitude of the resource implications of stress on equipment.

Differences Among the Services. The services vary greatly in their level of involvement in the ongoing operations associated with the war on terrorism. At the end of 2004, the Army had by far the greatest number of personnel—and pieces of equipment—deployed in Iraq and Afghanistan, with roughly 150,000 personnel in Iraq and Kuwait and an additional 14,000 personnel in Afghanistan.⁴ Those personnel were assigned to the equivalent of slightly more than five divisions and accompanying support units. Those large numbers of personnel needed equally large numbers of equip-

2. The rate of usage—or operating tempo—is typically measured in miles driven per vehicle per month or year, or hours flown per aircraft per month or year.
3. References to operations in Iraq and Afghanistan and surrounding theaters are meant to encompass all activities included in OIF and OEF.
4. The number of Army personnel in Iraq and Kuwait was increased temporarily at the end of calendar year 2004 to ensure security for Iraqi elections in January 2005.

ment—more than 35,000 trucks and some 1,700 helicopters, to cite two examples. The Marine Corps maintains a much smaller number of troops in-theater—roughly 30,000—and as a consequence much less equipment. (For example, the Marine Corps had roughly 5,000 trucks in Iraq compared with the Army’s 35,000.)

In contrast, the Air Force and the Navy, although supporting operations in Iraq, had far fewer pieces of equipment actually based there. Both services maintained support equipment in-theater—for example, the equipment associated with the Air Force Red Horse airfield maintenance and construction teams and Navy SeaBee units. But the number and value of the Air Force and Navy equipment based in-theater—other than aircraft—are small relative to that maintained in-theater by the Army and Marine Corps. Consequently, CBO chose not to include that equipment in its analysis.

Instead, CBO focused on the increased usage of and stress on those types of Navy and Air Force aircraft that have participated in OEF in Afghanistan and OIF in Iraq and on Navy ships and submarines that are stationed in the Iraqi theater. Although major equipment normally associated with those services—surface ships, submarines, and many fighter aircraft—were not heavily used in 2004, some Air Force and Navy aircraft and some Navy ships did experience significantly more use in 2004 in support of OEF and OIF, as well as in Operation Noble Eagle providing homeland defense of the United States. In short, CBO estimated the effect of increased demands associated with the war on terrorism on all Army and Marine Corps equipment used in the Iraqi and Afghani theaters, on Navy ships and submarines stationed in those theaters, and on Navy and Air Force aviation used to support OEF and OIF as well as the war on terrorism worldwide.

Two Different Methods. CBO used two different methods to estimate the increase in resource requirements compared with peacetime that would result from the increased use of equipment in conducting the war on terrorism. The first approach—referred to as the “top-down” approach—calculated the increased depreciation in the value of the services’ equipment that would result from increased usage rates. That approach assumes that all Army equipment in very broad categories, such as helicopters, experiences the same increase in OPTEMPO while deployed in the Iraqi and Afghani theaters. Thus, no variation in usage among individual types of Army trucks, helicopters, or tracked vehicles is taken into account. (In contrast, each individual type of Marine Corps equipment, Air Force aircraft, and Navy aircraft is treated independently.) The increased OPTEMPO is assumed to accelerate the aging of all equipment—either by type in the Air Force, Navy, and Marine Corps or for each category in the Army—at the same rate, thus increasing the need for equipment replacement over that experienced in peacetime. That approach yields insight into the costs of replacing or rebuilding equipment but not into the costs of maintaining it. That approach also requires the least data on specific types of equipment.

The second method is more detailed and attempts to calculate, for each type of equipment, the increased annual cost compared with peacetime for sustainment, mainte-

nance, repair, and replacement attributed to increased usage. Although that method—referred to as the “bottom-up” approach—would yield a more complete picture of the costs associated with increased equipment usage, it also requires much more extensive data. For each type of individual system class or model—such as an Abrams tank, a five-ton truck, or a UH-60 Blackhawk helicopter—CBO would need information on peacetime usage rates and per-hour or -mile costs for sustainment, maintenance, repair, and replacement. In those cases in which not all the necessary data were available for every system, CBO had to make assumptions or rely on analogies.

A detailed description of the analysis of equipment stress using each method, and the ensuing results, follows.

A Top-Down Approach to Estimating the Cost of Wear on Military Equipment in Ongoing Operations

This approach estimates the annual cost of excessive wear on equipment used in the war on terrorism on the basis of the premise that equipment operated at a higher-than-normal tempo must be replaced sooner than it would be under normal conditions.⁵ In particular, CBO assumed that equipment used at a higher-than-normal rate will age at a rate that is proportional to its usage. For example, using a piece of equipment at five times the normal rate will make it age five times faster than normal. CBO also assumed that pieces of military equipment have a fixed lifetime and must be replaced at the end of that lifetime to maintain the readiness of U.S. military forces. Thus, if the Army’s tanks have a nominal lifetime of 30 years, one-thirtieth of the total inventory would need to be replaced annually to maintain the average age—and the readiness—of the tank fleet at a constant level. In short, this approach assumes that increased usage accelerates the depreciation of the military’s equipment in-theater and that to maintain the military’s capability, an investment in new equipment must be made to offset that accelerated depreciation.

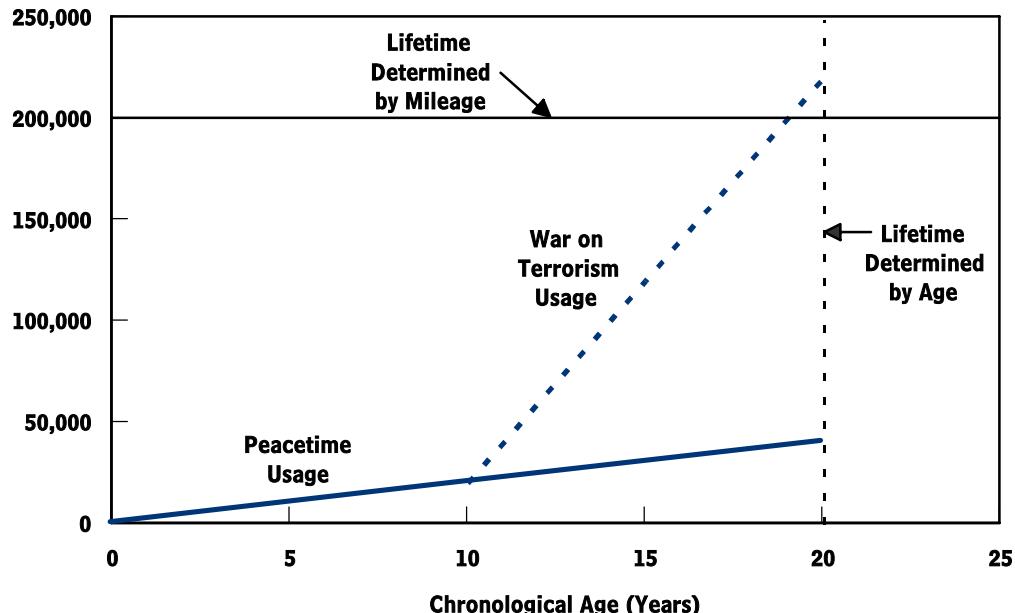
This method for estimating stress on equipment could overestimate some costs and underestimate others. First, just because a piece of equipment has been used intensively for one year does not necessarily mean that its remaining life has been reduced by more than one year. The peacetime usage rates of some pieces of military equipment are sufficiently low that usage at rates that are several times higher might not seriously stress a piece of equipment. For example, Army data indicate that the ser-

5. For the Army and the Marine Corps, almost all expenses related to excessive wear will result from operations in the Iraqi and Afghani theaters. Navy and Air Force aircraft might experience increased usage rates attributed to Operation Noble Eagle, conducted primarily in the United States, as well as for operations in Afghanistan and Iraq.

Figure 1.

Illustrative Relationship Between Vehicle Usage, Age, and Lifetime

(Miles on odometer)



Source: Congressional Budget Office.

vice's medium trucks drove an average of about 2,000 miles per year for the past eight years in peacetime operations. Based on the Army's goal of keeping an individual truck in its medium fleet for a maximum of 20 years, an average truck would have been driven a total of 40,000 miles during its lifetime—less than half as much as some commercial trucks are driven in one year.⁶ Thus, based on the Army's goals, the factors that limit the useful lifetime of an Army truck seem to be chronological age and technological obsolescence rather than total mileage (see the vertical line in Figure 1). If a 10-year-old Army truck with 20,000 miles on its odometer was shipped to Iraq and used at 10 times its peacetime rate of 2,000 miles per year, it would be 11 years old and have 40,000 miles on its odometer at the end of one year in Iraq. According to the method used by CBO in its analysis and by the services as the basis for some of their estimates of stressed equipment costs, that truck would be a candidate for replacement at the end of one year in Iraq because it would have aged 10 years during that year and reached the end of its 20-year lifetime. But if industry standards are more indicative of the mileage that a truck can reasonably expect to be driven, then a

6. Department of Energy, *Norcal Prototype LNG Truck Fleet: Final Results* (July 2004).

truck in Iraq could be driven 20,000 miles per year—10 times the peacetime rate—for up to eight years and still be below an illustrative lifetime mileage limit of 200,000 miles (see Figure 1). Thus, CBO’s estimate could overstate the services’ requirements. However, it is unlikely that carriers in the private sector keep their trucks in service as long as the Army does. As of April 2004, the average age of the Army’s almost 90,000 medium trucks was 19 years. Thus, a significant number of the Army’s trucks in Iraq and Afghanistan could already be more than 10 years old upon arrival in-theater. Usage at several times the usual peacetime rate may, indeed, push those trucks closer to the end of their useful lives.

A thorough analysis of the level of stress experienced by each type of system being used in Iraq and Afghanistan would require detailed knowledge of the status of each piece of equipment—such as its age and usage history, its design standards, and its usage in-theater. By adopting a top-down approach, CBO avoided the need for detailed data that are not available on the hundreds of thousands of individual pieces of equipment that the services have deployed to Iraq by generalizing the effects of increased usage on entire categories of equipment in the case of the Army and on each type of equipment for the other services.

Because CBO assumed that increased usage in-theater would yield a proportional increase in aging—using a piece of equipment at five times the peacetime rate would result in five years of aging for every year in-theater—CBO’s analysis did not take into account any additional aging that could result from operating in the harsh conditions of Iraq and Afghanistan. The dust, sand, and heat might tax engines and rotors, and heavy loads could strain axles and transmissions. And it is conceivable that those conditions could lead to a more-than-linear increase in aging and that usage at five times the peacetime rate could result in more than five years of aging in one year.⁷ CBO, however, has no analytical basis for estimating the increased stress caused by harsh conditions and so may have underestimated, in some cases, the actual stress from operations in the Iraqi and Afghani theaters.⁸

CBO also estimated the value of equipment that is projected to be damaged beyond repair. The amount of equipment that has had to be replaced annually because of excessive wear or damage has averaged roughly 2 percent for most types of Army

7. In some cases, trucks are carrying heavier loads than those typical of peacetime use. The weight of the armor that has been added to protect against mines, car bombs, and other explosive devices has also increased the wear and tear on trucks used in Iraq.
8. Although the services may have observed the effects of harsh desert conditions on their equipment, they have not, to CBO’s knowledge, derived a quantitative relationship between increased aging and operating in the desert that could be used in CBO’s analysis.

equipment in-theater.⁹ CBO assumed that the 2 percent annual rate of “total” loss would remain constant and apply to all types of Army and Marine Corps equipment. CBO also assumed that the Air Force and Navy would not lose any aircraft or ships.

To estimate the cost resulting from the increased usage and loss of equipment associated with the war on terrorism, CBO calculated the increase, relative to peacetime, in the value of equipment that would need to be replaced because of loss or accelerated aging. Because types and quantities of equipment, as well as the availability of data concerning equipment and usage rates, varied among the services, CBO evaluated the cost of equipment stress related to the war on terrorism separately for each service.

Current Levels of Equipment Stress

CBO estimated the cost of wear and tear on equipment for all four services that would accrue during operations in 2005 on the basis of the rate of usage experienced in 2004.¹⁰ CBO assumed that the Army and Marine Corps would maintain the same level of forces in Iraq and Afghanistan as were stationed there at the end of 2004. (CBO’s evaluation of Navy and Air Force equipment using the top-down approach was done on a fleetwide basis and was, therefore, independent of the level of Navy and Air Force personnel deployed in Iraq and Afghanistan.)

The Army accounts for the majority of the forces and equipment in Iraq and Afghanistan and has maintained roughly the same level of forces in-theater since operations in Iraq began in earnest approximately halfway through 2003. The Marine Corps has one Marine Expeditionary Force and parts of one division in Iraq and maintains considerable air and ground equipment in-theater. The Air Force and the Navy have a much smaller presence in-theater than the other two services but still play a role in current operations. Each service’s equipment and its usage in-theater will be discussed in turn.

Army Equipment Requirements. The Army has maintained 100,000 to 150,000 personnel in Iraq, Kuwait, and Afghanistan assigned to the equivalent of four to six divi-

9. Two percent of the Army’s missile systems, tracked vehicles, support equipment, and small arms returning from the Iraqi and Afghani theaters were damaged or worn beyond repair. Slightly higher loss rates—3 percent and 5 percent, respectively—applied to Army aviation and communication equipment. The Army’s wheeled vehicles suffered appreciably higher loss rates of 12 percent. Because CBO’s top-down analysis takes into account the much greater replacement rate that trucks would experience because of their high wartime OPTEMPO, CBO assessed the same 2 percent additional replacement rate for trucks that are beyond repair due to excessive wear or damage.
10. Usage rates for 2004 were not available for some types of Army equipment or for Navy aircraft. CBO assumed that usage rates for Army equipment in 2005 would equal those experienced in the last half of 2003 and that usage rates for Navy aircraft in 2005 would equal an average of the rates for 2002 and 2003.

Table 1.**Army Equipment Use In-Theater in 2005**

	Value of Equipment (Millions of dollars)		Assumed Lifetime (Years)	OPTEMPO Ratio (Wartime/ peacetime)	Increase in Annual Depreciation	
	In Divisions	Outside Divisions			Percent	Millions of Dollars
Aviation	4,150	8,980	20	2	5	660
Tracked Vehicles and Other Weapons	9,540	0	30	5	13	1,270
Trucks	2,110	1,930	20	10	45	1,820
Other	<u>4,630</u>	<u>0</u>	20	5	20	<u>930</u>
Total	20,430	10,910	n.a.	n.a.	n.a.	4,680

Source: Congressional Budget Office based on data from the Army.

Note: OPTEMPO = operating tempo; n.a. = not applicable.

sions and various other units from mid-2003 through the present.¹¹ CBO estimated the total value of the Army's combat equipment in the Iraqi and Afghani theaters by assuming that recent force levels, excluding the pre-election buildup, can be represented by five divisions—three heavy and two light. The value of the equipment associated with the divisions totals about \$20 billion, of which \$4 billion is aviation equipment; \$10 billion is ascribed to tracked vehicles and other weapons; \$2 billion is associated with trucks; and the remainder is associated with electronic equipment, generators, material-handling equipment, and other types of equipment (see Table 1). In addition, CBO took into account \$9 billion worth of aviation equipment in-theater that is not assigned to the divisions, as well as \$2 billion worth of trucks.

CBO treated those collective groups of equipment separately because of differences in assumed lifetime and increases in OPTEMPO relative to peacetime (see Table 1).¹² Specifically, CBO assumed that tracked vehicles would have a nominal lifetime of 30

11. The number of Army personnel in-theater increased during the transition period between unit rotations and then declined after the transition was completed. In addition, the number of Army personnel in the Iraqi theater (which includes Kuwait) was increased in December 2004 to ensure security for the elections at the end of January 2005. Those numbers are expected to decline in the spring of 2005.
12. The ratio of wartime OPTEMPO to peacetime OPTEMPO is a gauge of equipment use above peacetime levels. For example, a wartime-to-peacetime OPTEMPO ratio of 1.25 indicates that the system is used 25 percent more in wartime than in peacetime. A wartime-to-peacetime OPTEMPO ratio of 5 indicates a wartime usage at five times the peacetime rate and an increase in usage of 400 percent.

years, and all other types of equipment would be replaced every 20 years. Increases in OPTEMPO for equipment in-theater also varied greatly by equipment type. Army helicopters have been experiencing usage rates roughly twice peacetime rates, while tanks and other tracked vehicles have been experiencing usage at roughly five times peacetime activity levels. The Army's trucks, according to some reports, are being run at roughly 10 times peacetime rates and have been experiencing some of the worst problems attributed to wear and tear. (CBO assumed that all other Army equipment was being used at the same increased rate as tracked vehicles—five times peacetime rates.) Those assumptions resulted in slightly increased replacement rates for Army helicopters, tracked vehicles, and other equipment—5 percent, 13 percent, and 20 percent increases, respectively—and replacement rates for trucks that were 45 percent higher than in peacetime.

CBO estimates that the Army would need to invest roughly \$4.7 billion annually to maintain the current force levels and OPTEMPOs in Iraq and Afghanistan. The largest investments would be in trucks and tracked vehicles, which are experiencing some of the highest increases in OPTEMPOs relative to peacetime. Lesser amounts would be needed to replace helicopters and other equipment.

In addition to replacing equipment because of increased wear, the Army would have to replace equipment lost during operations. Based on the assumed annual loss of 2 percent, the Army would need to spend an additional \$600 million annually to replace lost equipment.

Marine Corps Equipment Requirements. As of the end of 2004, the Marine Corps had approximately 30,000 personnel deployed in the Iraqi theater with associated equipment worth more than \$6 billion. But in contrast with the Army's assets, which were dominated by trucks and tracked vehicles, aviation assets accounted for almost two-thirds of the total value of Marine Corps equipment (see Table 2). Using data provided by the Marine Corps, CBO was able to evaluate the wear and tear on each type of equipment individually. Although there was considerable variation in the rate of usage among the various Marine Corps systems, the overall patterns were similar to those of the Army systems. Helicopters in-theater were used at rates that averaged roughly twice that of peacetime, whereas trucks experienced the highest rate of usage—11 times as high as in peacetime. The Marine Corps' tracked vehicles and other weapons, including wheeled light armored vehicles (LAVs), experienced wartime OPTEMPOs roughly eight times those experienced in peacetime—somewhat higher than those of the Army's tracked vehicles.

Because the Marine Corps has fewer forces in Iraq and Afghanistan than the Army does, its annual costs for depreciation caused by wear and tear and for losses in the theater are also much lower than the Army's, according to CBO's estimates. In total, the Marine Corps would need to invest roughly \$1 billion annually to replace the

Table 2.**Marine Corps Equipment Use In-Theater in 2005**

	Value of Equipment (Millions of dollars)	Assumed Lifetime (Years)	OPTEMPO Ratio (Wartime/peacetime)	Increase in Annual Depreciation (Millions of dollars)
Aircraft				
Fighters	1,090	25	1.4–3.6	65
Tankers	500	30	1.7	10
Helicopters	2,425	20	1.6–2.3	135
Total	4,015	n.a.	n.a.	210
Ground Equipment				
Tracked Vehicles and Other Weapons	1,075	30	8	255
Trucks	805	20	11	415
Other	555	20	4	125
Total	2,435	n.a.	n.a.	795

Source: Congressional Budget Office based on data from the Marine Corps.

Note: OPTEMPO = operating tempo; n.a. = not applicable.

worn equipment in its inventory. As with the Army, the bulk of the expense—more than three-quarters—would be for ground equipment. Because of their greatly increased OPTEMPOs, tracked vehicles and other weapons and trucks would need the biggest infusion of funds—a total of \$670 million annually. Finally, on the basis of an assumed loss rate of 2 percent per year, the Marine Corps would need to spend about \$130 million annually to replace equipment damaged beyond repair.

Air Force Equipment Requirements. CBO’s analysis of the stress on Air Force equipment attributed to the war on terrorism differed from that of the Army and the Marine Corps in two ways. First, CBO limited its analysis to Air Force aircraft because, even though the Air Force does have some ground equipment in the Iraqi theater, aircraft make up the bulk of the service’s assets. Second, because the Air Force did not provide CBO with detailed information concerning which Air Force assets have been involved in operations in Iraq and Afghanistan, or what the OPTEMPO of those assets has been, CBO conducted a fleetwide analysis to estimate the increased wear and tear on Air Force aircraft.

Table 3.**Air Force Aircraft Use in Ongoing Operations in 2005**

	Inventory		Value of Equipment (Millions of dollars)	OPTEMPO Ratio (Wartime/peacetime)	Increase in Annual Depreciation (Millions of dollars)	
	Number of Models	Number of Aircraft			Aircraft Lifetime	40 Years
Transporters	5	733	99,460	1.28	750	1,000
Tankers	2	552	66,180	1.23	380	500
Bombers	2	81	43,170	1.39	290	390
Fighters	2	1,625	39,190	1.03	40	50
Gunships	1	20	3,950	1.30	30	40
Other ^a	<u>3</u>	<u>54</u>	<u>16,160</u>	1.16	<u>60</u>	<u>80</u>
Total	15	3,063	268,110	n.a.	1,540	2,060

Source: Congressional Budget Office based on data from the Air Force.

Note: OPTEMPO = operating tempo; n.a. = not applicable.

a. Includes three types of surveillance and reconnaissance aircraft.

CBO based its analysis on information from the Air Force Total Operating Cost (AFTOC) database, which includes information on the number of aircraft in the Air Force's inventory and the number of hours that they have flown in a given year. CBO estimated the increased depreciation for those Air Force fleets that included at least 10 aircraft and that flew at least 3 percent more hours in 2004 than they averaged annually from 1996 through 2001.¹³ Fifteen types of aircraft met those criteria, including most of the Air Force's tankers and transport aircraft. (Of the Air Force's fighter aircraft fleets, only two—the A-10 and the F-16—exhibited overall OPTEMPOs for 2004 that were at least 3 percent higher than peacetime.) Of the classes of aircraft that CBO examined, the Air Force's B-1 bomber fleet exhibited the highest relative increase in OPTEMPO, with a 47 percent average increase. (The combined B-1 and B-2 fleets together experienced a 39 percent increase above peacetime OPTEMPO.) Transport and tanker aircraft and the AC-130 gunship experienced large increases in OPTEMPO as well—28 percent, 23 percent, and 30 percent, respectively—with the remainder of the fleets exhibiting smaller increases (see Table 3). Because of the increase in hours flown over those typically flown in peacetime, those aircraft could depreciate faster than planned. By CBO's estimate, that accelerated depreciation

13. CBO excluded from this analysis the Air Force's training aircraft. CBO also excluded one aircraft—the WC-130 weather surveillance aircraft—that met its criteria but is designated for specific missions not related to the war on terrorism.

Table 4.**Navy Aircraft Use in Ongoing Operations in 2005**

	Inventory	Value of Equipment	Assumed Lifetime	OPTEMPO Ratio	Increase in Annual Depreciation	
	Number of Models	Number of Aircraft	(Millions of dollars)	(Years)	(Wartime/peacetime)	(Millions of dollars)
Patrol	2	262	9,070	30–40	1.15	35–45
Early Warning	1	52	4,320	30–40	1.03	5
Fighter	3	404	12,640	25	1.14	75
Helicopter	<u>3</u>	<u>166</u>	<u>5,010</u>	20	1.14	<u>35</u>
Total	9	884	31,040	n.a.	n.a.	150–160

Source: Congressional Budget Office based on data from the Navy.

Note: OPTEMPO = operating tempo; n.a. = not applicable.

could result in a total cost for the Air Force ranging from \$1.5 billion to \$2.1 billion for 2005 and for each year in which operations are carried out at the same rate.¹⁴

Navy Equipment Requirements. As with its analysis of the Air Force's equipment requirements, CBO's analysis of naval equipment requirements using the top-down approach focuses solely on aviation and is based on a fleetwide analysis.¹⁵ Only those types of aircraft that are participating in the war on terrorism (as indicated by the Navy), have at least 10 airplanes in their inventory, and experienced OPTEMPOs exceeding their average peacetime OPTEMPO by at least 3 percent were included in CBO's analysis. Nine types of aircraft met those criteria, including three models of fighters, three types of helicopters, the E-2C early-warning aircraft, and the P-3 and S-3 patrol fleets.¹⁶ None of the overall fleets experienced particularly high increases in OPTEMPO as a result of the war on terrorism; patrol aircraft had the largest increase—15 percent (see Table 4). Because the increases in OPTEMPO are relatively small and because the Navy's aircraft fleet is smaller than the Air Force's, the Navy's

14. The range reflects uncertainty regarding the likely lifetime of the Air Force's fleets. CBO used nominal lifetimes of 30 years and 40 years to reflect the fact that the Air Force has retained these types of aircraft for extended periods in the past.

15. Although CBO included Navy ships and submarines in its bottom-up analysis, it did not include them in its top-down analysis because their increased usage is not likely to result in the need for accelerated replacement.

16. As with the Air Force, some of the Navy's aircraft might have experienced higher OPTEMPOs because of activity associated with Operation Noble Eagle or other war on terrorism-related activities outside of Iraq or Afghanistan.

Table 5.

Estimated Total Cost to Replace and Refurbish the Services' Equipment in 2005

(Billions of dollars)

	Stress	Loss	Total
Army	4.7	0.6	5.3
Marine Corps	1.0	0.1	1.1
Air Force ^a	1.5–2.1	0	1.5–2.1
Navy	<u>0.2</u>	<u>0</u>	<u>0.2</u>
Total	7.4–8.0	0.7	8.1–8.6

Source: Congressional Budget Office.

a. Range reflects assumed lifetime of 30 years to 40 years for Air Force aircraft.

annual cost for wear and tear is the smallest among the four services. CBO estimates that cost to be approximately \$150 million, with the fighter fleet accounting for roughly half of it.

Costs of Wear to Equipment in 2005 Across the Four Services. CBO estimates that the requirement in 2005 for funds to replace equipment from all four services that is worn out or is beyond repair—defined as a “loss”—would total between \$8 billion and \$9 billion (see Table 5). The Army would need \$5.3 billion in replacement funds; the Air Force, up to \$2.1 billion; the Marine Corps, \$1.1 billion; and the Navy, about \$0.2 billion.

Changes in Equipment Costs over Time

CBO attempted to determine whether any requirements for funds to offset equipment wear and loss have accumulated from years prior to 2005 and if so, how big the backlog might be. CBO also attempted to estimate the size of the bill for equipment stress and loss in future years.

Backlog of Unmet Requirements from Previous Years. CBO’s estimate of annual funds required to replace worn-out and lost equipment discussed in the previous section was based on force levels expected for 2005 and operating tempos experienced in 2004. However, each of the services has incurred expenses related to wear on equipment and loss for the years preceding 2005 during which operations related to the war on terrorism were conducted. Large numbers of U.S. ground forces began arriving in Kuwait in preparation for invading Iraq in December 2002, and data in the Army’s Operating and Support Management Information System (OSMIS) reflect increased OPTEMPOs for Army equipment in the last two quarters of 2003. CBO therefore assumed that the equipment stress projected for 2005 could also have occurred in the

second half of 2003 and throughout 2004.¹⁷ The total accumulated cost for the years 2003, 2004, and 2005 associated with equipment stress based on CBO's estimate would equal \$20 billion to \$22 billion.

The services have, of course, received some funds in supplemental appropriations with which to address equipment wear and tear. But it is not easy to determine how much of the roughly \$197 billion (in then-year dollars) that had been appropriated to the Department of Defense (DoD) by the end of calendar year 2004 to support the war on terrorism has been used to address that issue.¹⁸ Since the start of operations in Iraq, more than \$100 billion of the \$197 billion has been allotted to operations and maintenance, and some of those funds have undoubtedly been used to repair stressed equipment, although the majority has probably been used to pay for fuel and other operating costs. Almost \$13 billion (in then-year dollars) has been appropriated since OIF began to procure items to conduct the war on terrorism, and some of that funding has been devoted to purchasing replacements for lost equipment. But it is not possible to determine definitively what portion of those appropriated funds has been devoted specifically to addressing the effects of excessive wear using data available from DoD.

To get an idea of how much funding has been used for those purposes, CBO made several assumptions. First, CBO assumed that all supplemental funds allotted to depot maintenance would be devoted to overhauling equipment that had been damaged or excessively worn in operations related to the war on terrorism. Second, funds allotted to procure major pieces of equipment, such as trucks, were also assumed to offset equipment wear and loss. Finally, CBO relied on information in briefings it received from the services to try to identify supplemental funding that could be used to offset the more than \$20 billion cost that might accrue through 2005. All told, CBO identified a total of more than \$3 billion that may have been appropriated—primarily in 2004—for overhauling and replacing stressed and lost equipment. Of that total, the bulk—\$1.6 billion—was provided to the Army (see Table 6). Based on those assumptions, an estimated total backlog of roughly \$18 billion in costs related to equipment wear and loss may accumulate by the end of 2005 if the services receive no additional funding.¹⁹

17. The level of ground forces in and around the Iraqi theater has remained relatively constant since the middle of 2003.
18. Press reports indicate that the Army plans to hire an independent auditing firm to help it determine how it spent its supplemental budgets. It has decided to do so, according to its solicitation, in part because the “challenges in providing a clean accounting of [war on terrorism] costs include . . . costs associated with the maintenance and repair of military equipment in support of” the war on terrorism. See “Army Wants Outside Audit of Terrorism War Spending” (Defense Alert, February 9, 2005), available at <http://insidedefense.com/>.
19. That estimate does not take into account funds requested for equipment stress in the 2005 supplemental funding request submitted in February 2005.

Table 6.

Costs and Funds Appropriated for Equipment Stress and Loss, 2003 to 2005

(Billions of dollars)

	Costs Accrued (2003-2005)	Appropriated ^a (2003 and 2004)	Total Unpaid Costs Accrued Through 2005
Army	13.2	1.6	11.6
Marine Corps	2.8	0.1	2.7
Air Force ^b	3.9-5.2	0.7	3.2-4.5
Navy	<u>0.4</u>	<u>0.8</u>	<u>0.2^c</u>
Total	20.3-21.6	3.2	17.7-18.9

Source: Congressional Budget Office.

- a. Does not include funds requested for equipment stress in the 2005 supplemental request submitted in February 2005.
- b. Range reflects assumed lifetime of 30 years to 40 years for Air Force aircraft.
- c. Costs for 2005.

Future Requirements Related to Equipment Stress and Loss. CBO assumed that the security situation in Iraq will improve over the next several years and, as a result, both the level of U.S. forces and the pace of operations will diminish. Because there is no official timetable for either a drawdown of forces or an easing of the pace, CBO assumed a gradual reduction of both until a steady state is achieved in 2010 (see Figure 2).²⁰ The end state achieved in 2010 is consistent with maintaining a total of four Army brigades in the Iraqi and Afghani theaters—or otherwise involved in operations associated with the war on terrorism—and an activity level that would be only slightly higher than that experienced in peacetime. (CBO assumed that all other forces in-theater—specifically Army units outside of the divisions and units from the Marine Corps—would draw down proportionately with the Army divisions.)

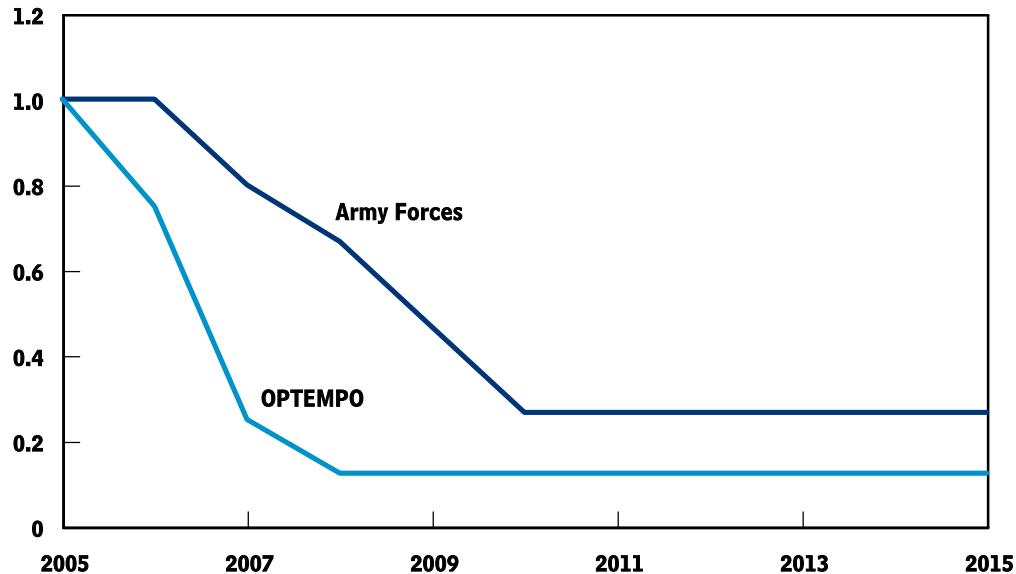
The combination of reduced force levels and a decreased OPTEMPO would result in significantly fewer pieces of equipment that would need replacing or refurbishing. As a result, the annual cost related to equipment stress and loss would drop from between \$8 billion and \$9 billion in 2005 to roughly \$800 million by 2010. If the backlog of unmet requirements from 2003 and 2004 is included in the funding required for 2005, and if the backlog is indeed eliminated, then the annual funding needed drops

20. Those force levels are consistent with the ones used to determine potential future spending for activities in Iraq, Afghanistan, and the war on terrorism in CBO's *Budget and Economic Outlook: Fiscal Years 2006 to 2015* (January 2005).

Figure 2.

Assumed Reductions in Forces and Operating Tempo from the 2005 Level

(Scaling factor)



Source: Congressional Budget Office.

Notes: Forces in a given year = (Forces Scaling Factor for that year) x (level of forces in 2005).

The ratio of wartime OPTEMPO to peacetime OPTEMPO in a given year = $1 + (\text{OPTEMPO Scaling Factor for that year}) \times [(\text{wartime OPTEMPO in 2005}/\text{peacetime OPTEMPO in 2005}) - 1]$.

dramatically from between \$18 billion and \$19 billion in 2005 to roughly \$800 million in the out-years (see Figure 3).

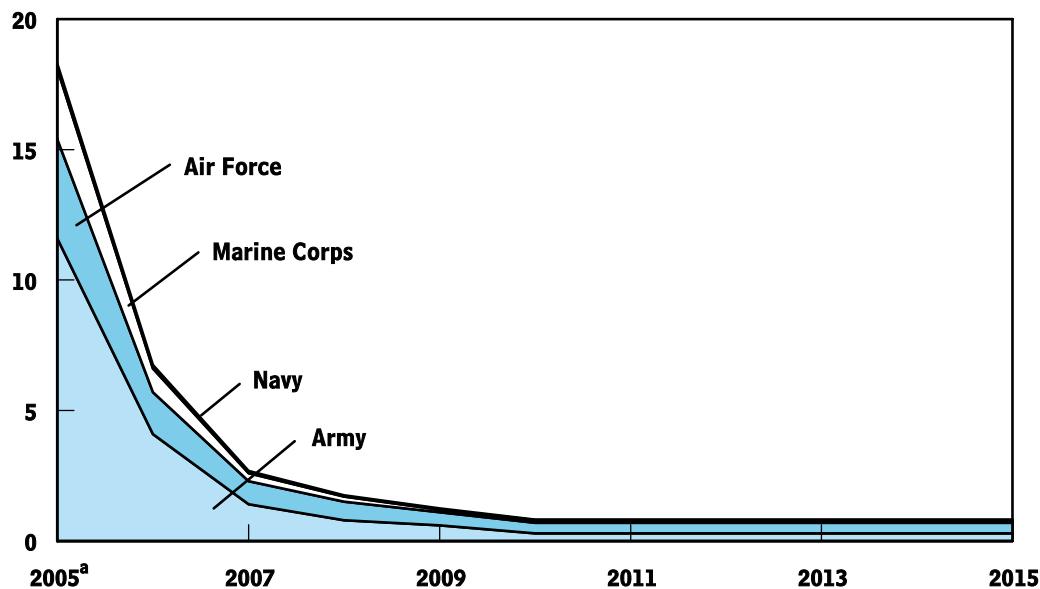
A Bottom-Up Approach to Estimating the Cost of Wear on Equipment

An alternative to the top-down depreciation method for estimating the costs of wear on equipment is to calculate from the “bottom up” the costs for all maintenance activities that must be performed on military equipment being used in the war on terrorism, as well as the costs to replace equipment destroyed or worn beyond repair. In the bottom-up approach, CBO defines five categories of maintenance and replacement activities: sustain, restore to standard in-theater, restore to standard at depot, recapitalize, and replace (see Box 1 on page 20 and Figure 4 on page 21). The unit of analysis is an individual system class or model, such as the M1A1 Abrams tank or the C-5 transport aircraft. The total costs of wear on equipment attributable to operations related to the war on terrorism are those to perform all maintenance activities on each piece of equipment being used and to replace equipment as needed.

Figure 3.

Annual Funds Needed to Replace Equipment Lost Because of Stress and Damage in Contingency Operations, Based on CBO's Top-Down Approach

(Billions of dollars)



Source: Congressional Budget Office.

a. Includes backlog of unfunded requirements from 2003 and 2004.

The data available determined the methods CBO used to estimate maintenance-activity costs arising from those operations—that is, the costs over and above those associated with peacetime usage of equipment:

- For all the services' equipment, historical data were available to derive the marginal or average costs for sustaining equipment per mile driven, hour flown, or day steaming.²¹
- In some cases, analysis of historical data permitted the derivation of either the marginal costs or average costs for all maintenance activities collectively (including sustainment) per mile, hour, or day (see Figure 5 on page 22).

21. Wheeled- and tracked-vehicle use is generally measured in terms of miles. Ship use is measured in terms of days. Most other equipment use is measured in terms of hours. CBO refers to miles, hours, and days interchangeably in this analysis.

When regression analysis yielded a positive and statistically significant relationship between costs and equipment use, CBO used the slope of that relationship as the marginal cost of hours in excess of peacetime. If regression analysis proved unstable, CBO instead used the simple ratio of average maintenance spending to average hours.

Box 1.

Maintenance and Replacement Activities

The Congressional Budget Office (CBO) divided costs for wear on equipment into five categories that represent a classification of all possible maintenance and replacement actions (see Figure 4). That categorization is similar to the breakdown of equipment-stress estimates that the Office of the Secretary of Defense directed the services to use in the preparation of their background material for justifying the supplemental budget request for 2005. Activities at the base of the pyramid are less costly, but performed more frequently, than activities at the apex. The typical location where each activity is performed is indicated in parentheses.

“Sustainment” involves routine maintenance tasks such as inspection, lubrication, and replacement of minor parts. All systems require sustainment activity. If equipment is not regularly maintained, it may require more-serious repair or fail prematurely in the future. Sustainment occurs continually at the unit level, in garrison during peacetime, or in-theater during contingency operations. This category does not include operational costs, such as fuel, that are not related to equipment maintenance.

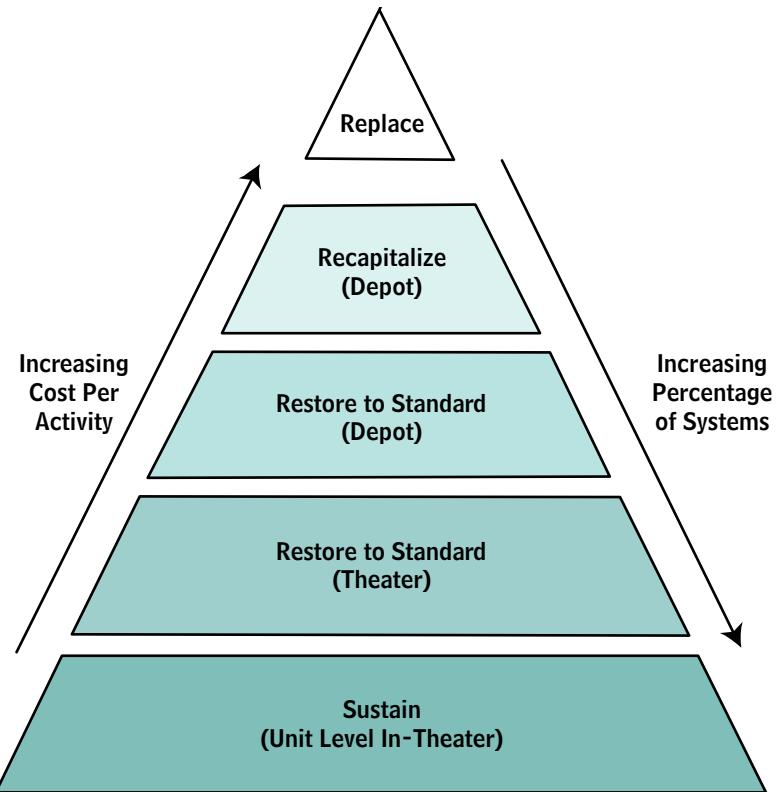
“Restoring to standard” involves repairing equipment so that it meets established capability requirements. The Army, for example, repairs a system so it meets standards set in the Army’s series 10 and 20 technical manuals. Restoring to standard is more complex and costly than sustainment and is performed as needed rather than on a continual basis. Depending on the level of repair required, restoring to standard may be performed in theater installations or at an organic or contractor depot facility in the United States. Work conducted at the depot is more exhaustive and expensive.

“Recapitalization” involves rebuilding and upgrading a system’s components. A significant investment of labor and money, recapitalization returns systems to almost new (zero-mile or zero-hour) condition. Recapitalization can also reduce a system’s subsequent operating and support costs and enhance its capability through component upgrades. Not all systems are candidates for recapitalization; appropriate programs and facilities must be in place.

“Replacement” indicates that the system has been damaged beyond the point at which it is cost-effective to repair. Irreparable equipment damage may be the result of combat or heavy wear. CBO assumes that those systems are replaced with newly procured systems, if available, or systems pulled from surplus. In some cases, replacement cannot occur because a comparable replacement does not exist or the system is scheduled to be phased out of the force structure.

The services, particularly the Army, frequently refer to the need to “reset” the force following contingency operations. CBO considers reset to be a generic term indicating the return of equipment’s combat capability to a level equal to its capability prior to the operation. By that definition, the categories restoring to standard, recapitalization, and replacement all qualify as reset.

Figure 4.
Maintenance and Replacement Activities



Source: Congressional Budget Office.

- For some equipment, historical data on maintenance costs were either unavailable or incomplete. In such cases, CBO prepared its estimates using either historical data for costs to maintain analogous equipment or data provided by the services for expected maintenance and replacement costs.

For a summary of the methods CBO used to estimate costs attributable to worn equipment for each of the services' major types of equipment, see Table 7 on page 23.

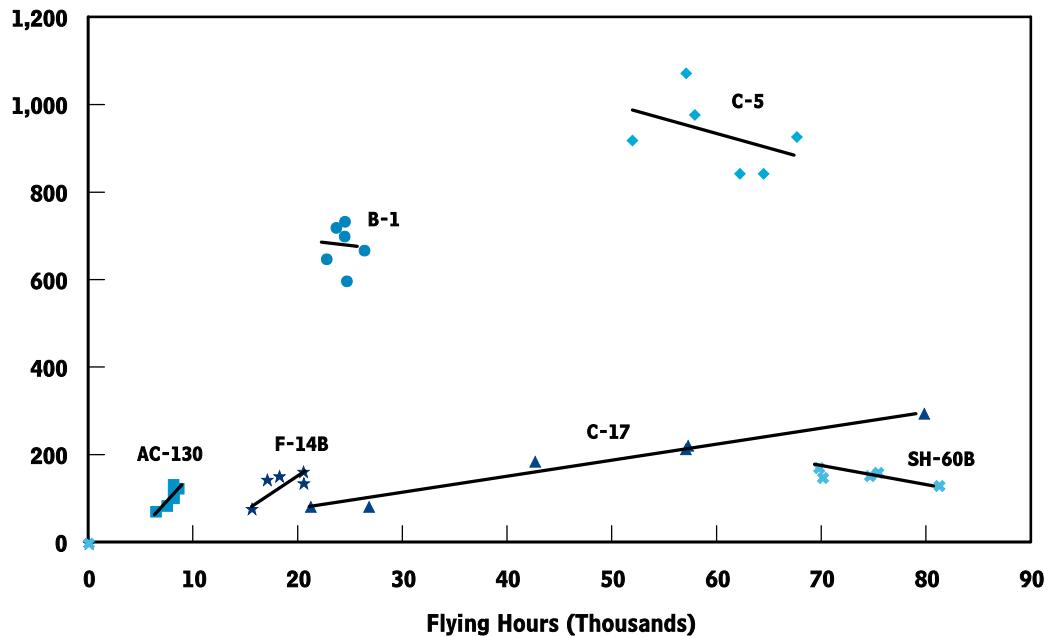
Army Requirements

The Army, by virtue of fielding the most equipment in-theater, requires the highest additional maintenance and replacement spending among the services. Because the Army fields hundreds of different systems, CBO selected a subset comprising the major Army equipment being used in Iraq and Afghanistan. These systems match those considered in the top-down depreciation calculations and constitute most of the total dollar value of Army equipment. The Army did not provide CBO with an estimate of the quantity of each system in-theater. CBO instead generated its own estimate of equipment quantities based on the number and types of Army units deployed in-theater.

Figure 5.

Examples of Peacetime Relationship Between Annual Flying Hours and Total Maintenance Spending

(Millions of dollars)



Source: Congressional Budget Office based on data from the Air Force Total Ownership Cost database and the Navy's Visibility and Management of Operating and Support Costs database.

CBO examined historical data for the years 1993 through 2003 contained in the Army's Operating and Support Management Information System. To estimate sustainment costs, CBO relied on past consumable and reparable spending records, as well as equipment usage data, contained in OSMIS. By performing a regression analysis, CBO calculated system-specific sustainment costs per additional mile or hour. When a statistically significant relationship between cost and use was not found, CBO instead calculated an average cost per mile. On the basis of wartime OPTEMPO data provided by the Army, CBO then estimated the additional miles or hours of use attributable to operations in Iraq and Afghanistan for each system. Sustainment costs attributable to operations equal the additional miles operated multiplied by the marginal or average cost per mile. Because the Army provided CBO with only rough estimates of wartime OPTEMPOs, CBO used ranges based on the type of equipment, such as aircraft or wheeled vehicle. Those ranges, in turn, generated ranges of sustainment costs.

For maintenance activities above sustainment, as well as replacement, CBO concluded that the OSMIS data did not consistently capture all the costs necessary for the estimate of wear on equipment. Thus, CBO used maintenance activity and replacement needs, and the associated costs, provided by the Army. Those estimates were

Table 7.

The Basis for Estimating Costs for Each Activity Using the “Bottom-Up” Approach

Equipment Type	Restoring to Standard				
	Sustainment	In-Theater	At Depot	Recapitalization	Replacement
Army					
Aircraft	Marginal cost per hour	Service-provided data	Service-provided data	n.a.	Procurement cost
Ground	Marginal cost per mile	Service-provided data	Service-provided data	Service-provided data	Procurement cost
Marine Corps					
Aircraft	Marginal cost per hour	Marginal cost per hour	Marginal cost per hour	n.a.	Procurement cost
Ground	Marginal cost per mile	Service-provided data	Service-provided data	n.a.	Procurement cost
Air Force^a					
Aircraft	Marginal cost per hour	Marginal cost per hour	Marginal cost per hour	n.a.	n.a.
Navy^a					
Aircraft	Marginal cost per hour	Marginal cost per hour	Marginal cost per hour	n.a.	n.a.
Ships	Marginal cost per day	Marginal cost per day	Marginal cost per day	n.a.	n.a.

Source: Congressional Budget Office.

Note: n.a. = not applicable.

a. Ground equipment were not analyzed.

based largely on Army briefings and data containing replacement, recapitalization, and restoration (in-theater and depot) rates and costs.²² If data were not available for a system, CBO assumed rates and costs approximately equal to those of similar pieces of equipment. To accommodate uncertainty in those rates, CBO again used ranges rather than point estimates.

On the basis of those bottom-up estimates, the Army needs between \$3.7 billion and \$5.3 billion annually to pay for maintenance-activity and replacement requirements attributable to operations in Iraq and Afghanistan (see Table 8). Wheeled vehicles constitute the largest portion of that requirement because of their high wartime-to-

22. Those data comprise estimates of the percentage of each system’s inventory in Iraq and Afghanistan requiring in-theater restoration, depot restoration, recapitalization, and replacement at rates exceeding peacetime levels.

Table 8.

Army Maintenance and Replacement Costs Resulting from Operations in 2005

(Millions of dollars)

Equipment Type	Total Increased Costs
Aircraft	1,090–1,580
Tracked Vehicles	1,080–1,500
Wheeled Vehicles	<u>1,510–2,260</u>
Total	3,680–5,340

Source: Congressional Budget Office based on Army briefings and data from the Army's Operating and Support Management Information System.

peacetime OPTEMPO ratios and large numbers in-theater. Because of data constraints, CBO's analysis did not consider minor equipment, such as electronics and firearms, that could add to the estimate of wear on equipment. However, CBO believes that the maintenance costs of those less expensive systems are much smaller than for aircraft, tracked vehicles, or wheeled vehicles.

Marine Corps Requirements

The Marine Corps also has a substantial amount of equipment—and resulting maintenance-activity costs—in Iraq and Afghanistan, although not nearly as much as the Army. CBO's source of historical maintenance expenditures and equipment usage, the Visibility and Management of Operating and Support Costs (VAMOSC) database, contained detailed enough data to calculate total maintenance costs per hour for Marine Corps aircraft but not ground equipment.²³ Consequently, CBO analyzed ground equipment using the same technique as it used for Army equipment.

The Marine Corps provided equipment quantities and wartime-to-peacetime OPTEMPO ratios for most major ground equipment in-theater. System sustainment costs per mile were calculated on the basis of a regression analysis of historical consumable and repairable costs and equipment usage. If data were not available, CBO assumed sustainment costs per additional mile were approximately equal to those of analogous Army ground equipment.

For restoration, recapitalization, and replacement activities, CBO calculated system-specific costs by multiplying the expected number of items requiring each activity by the cost to perform each type of activity. CBO used estimates of activity rates and costs presented in a Marine Corps briefing and cross-checked those data with Army data for similar systems. According to the Marine Corps, it does not have any require-

23. VAMOSC contains both Marine Corps and Navy data.

ments to recapitalize or restore ground equipment to standard in-theater. The Marine Corps currently performs all maintenance activities above sustainment in the continental United States.

For Marine Corps aircraft, historical aircraft maintenance cost data and flying-hour numbers from the VAMOSC database allowed CBO to calculate a full maintenance cost per additional flying hour.²⁴ That cost includes all maintenance activities (including sustainment) except recapitalization—for which the Marine Corps has no requirements.

The Marine Corps provided CBO with aircraft quantities and wartime-to-peacetime OPTEMPO ratios for operations in Iraq and Afghanistan. However, the OPTEMPO ratios were not based on a full year's worth of data, so CBO employed ranges in its estimate. Using those ranges in conjunction with historical VAMOSC data on peacetime flying hours (for the period spanning 1997 to 2001), CBO calculated the additional flying hours resulting from contingency operations. For each aircraft model, the cost of wear on equipment was determined by multiplying flying hours attributable to operations in Iraq and Afghanistan by the additional maintenance costs per hour. The Marine Corps also provided data on the number and type of aircraft lost or damaged beyond repair since the war on terrorism began, which CBO used to estimate an annual percentage of aircraft lost.

On the basis of those bottom-up estimates, the Marine Corps needs between \$800 million and \$1.3 billion annually to pay for maintenance-activity and replacement requirements attributable to Iraq and Afghanistan (see Table 9). Aircraft and wheeled vehicles constitute the largest portions of that requirement.

Air Force Requirements

CBO's analysis of the Air Force's wear on equipment focused on aircraft. The Air Force does have ground equipment participating in the war on terrorism, but the estimated value of that equipment, about \$1.7 billion, is only a fraction of that for aircraft.

CBO was able to estimate the total maintenance cost per additional Air Force aircraft flying hour on the basis of historical data, as it did in the Marine Corps aircraft analysis. The Air Force did not provide OPTEMPOs, so CBO calculated aircraft-model OPTEMPO ranges using data from the Air Force Total Ownership Cost database. (AFTOC contained data up through the entire fiscal year 2004.) In addition, because the Air Force did not provide estimates of the number of aircraft involved in Iraq and

24. For the purpose of that estimate, CBO defined maintenance costs as all aircraft maintenance-related expenses that vary with the number of hours flown. Those costs include such items as reparables, consumables, aircraft and engine rework at the depot, civilian and contractor personnel costs, and engineering services. CBO did not include military personnel costs, since they are generally fixed and independent of the number of hours flown.

Table 9.

Marine Corps Maintenance and Replacement Costs Resulting from Operations in 2005

(Millions of dollars)

Equipment Type	Total
Aircraft	310–400
Tracked Vehicles	140–240
Wheeled Vehicles	300–480
Other	<u>90–160</u>
Total	840–1,280

Source: Congressional Budget Office based on Marine Corps briefings and the Visibility and Management of Operating and Support Costs database.

Afghanistan, CBO had to perform a fleetwide analysis rather than focus only on aircraft in-theater.²⁵

CBO analyzed only aircraft models that are flying at least 3 percent more hours annually than in peacetime and whose fleets are composed of at least 10 aircraft.²⁶ On the basis of CBO's calculations, the Air Force needs between \$1.2 billion and \$1.8 billion annually to pay for maintenance-activity and replacement requirements attributable to operations associated with the war on terrorism (see Table 10). The tanker and transport fleets are experiencing the largest total increase in flying hours because of contingency operations and as a result constitute about three-quarters of the estimate for wear on equipment. According to the Air Force, it does not need to replace any of its aircraft as a result of contingency operations.

Navy Requirements

CBO's analysis of Navy systems included aircraft and ships but not ground equipment, which represents only a small portion of the value of all Navy equipment participating in-theater. For aircraft, CBO again used historical data to estimate maintenance costs per additional flying hour. CBO considered only aircraft that are participating in the war on terrorism (as indicated by the Navy), that are flying at least 3 percent more hours annually than in peacetime and whose fleets are composed of at least

25. Although OPTEMPO increases are lower in a fleetwide analysis (because they are calculated across the entire fleet rather than only for aircraft involved in operations stemming from the war on terrorism), they are applied to a larger population of aircraft. Therefore, assuming the data are accurate, a fleetwide analysis and an analysis of only contingency-operation aircraft should produce the same result.

26. CBO did not include the WC-130 hurricane reconnaissance aircraft in its analysis, although that aircraft did meet the selection criteria.

Table 10.

Air Force Maintenance and Replacement Costs Resulting from Operations in 2005

(Millions of dollars)

Aircraft Type	All Maintenance
Bombers	130–300
Fighters	80–120
Reconnaissance and Special Duty	80–100
Transports and Tankers	<u>940–1,250</u>
Total	1,230–1,770

Source: Congressional Budget Office based on Air Force briefings and the Air Force Total Ownership Cost database.

10 aircraft. The historical flying-hour and cost data contained in VAMOSC spanned 1997 through 2003. The Navy did provide more recent flying-hour data, but it included aircraft operated by the Marine Corps, which CBO analyzed separately. The Navy currently does not need to recapitalize or replace any aircraft.

For ships and submarines, CBO assumed that the Navy would continue to maintain a Carrier Strike Group (CSG) and an Expeditionary Strike Group (ESG) in-theater. The specific CSG and ESG participating in contingency operations change as groups rotate into and out of theater, so CBO generated its estimate on the basis of a generic CSG and ESG comprising a total of 13 ships. Using historical data from VAMOSC, CBO was able to calculate an average total maintenance cost per steaming day for each ship class.²⁷ According to the Navy, ships in the Iraqi and Afghani theaters are generally steaming 20 days more per quarter than in peacetime (an annual difference of 80 days per ship). To estimate the maintenance costs attributable to that increased operation, CBO multiplied the cost per steaming day by the number of additional steaming days. The Navy does not have any ship replacement requirements resulting from operations in-theater.

On the basis of those estimates, the Navy needs approximately \$250 million to \$350 million to pay for maintenance-activity and replacement requirements attributable to operations stemming from the war on terrorism, about half of which is for ships (see

27. CBO did not perform a regression analysis of historical ship-use and maintenance-cost data, since annual steaming hours per ship class are approximately constant in peacetime. CBO believes that the average cost per steaming day is probably an overestimate of the actual ship-maintenance cost per additional steaming day. Ship maintenance, particularly for activities above sustainment, is usually dictated by the age of a ship, rather than the number of days it was steaming. Consequently, some ship-maintenance costs are fixed and do not vary with ship usage.

Table 11.

Navy Maintenance and Replacement Costs Resulting from Operations in 2005

(Millions of dollars)

Equipment Type	Total
Aircraft	100–180
Ships and Submarines	<u>150–170</u>
Total	250–350

Source: Congressional Budget Office based on Navy briefings and the Visibility and Management of Operating and Support Costs database.

Table 11). Because of a lack of data, CBO did not consider the Military Sealift Command in its analysis.

Accumulated and Future Requirements Related to Equipment Stress and Loss

CBO used the bottom-up approach to estimate the costs of wear on equipment for years prior to 2005, and for future years, consistent with the assumptions described previously regarding the force levels and pace of operations in Iraq and Afghanistan. Based on the bottom-up estimates, the total cost associated with equipment stress for the years 2003, 2004, and 2005 is approximately \$18 billion. The services have already received some funds in supplemental appropriations to pay for the maintenance activities that are addressed in the bottom-up approach, although the exact amount is unclear. CBO estimates that supplemental appropriations enacted in 2002, 2003, and 2004 provided about \$5 billion to \$6 billion for equipment maintenance and replacement resulting from the war on terrorism. That estimate includes the cost of all maintenance activities except sustainment, which CBO believes is paid for out of the general operation and maintenance funds included in the supplemental appropriations. On the basis of those estimates, a total backlog of \$13 billion for wear on equipment will have accumulated by the end of 2005. After 2005, the annual cost related to wear on equipment will gradually decrease from \$5.8 billion in 2006 to a steady-state value of less than \$600 million in 2010 and beyond, based on CBO's assumptions (see Figure 6).

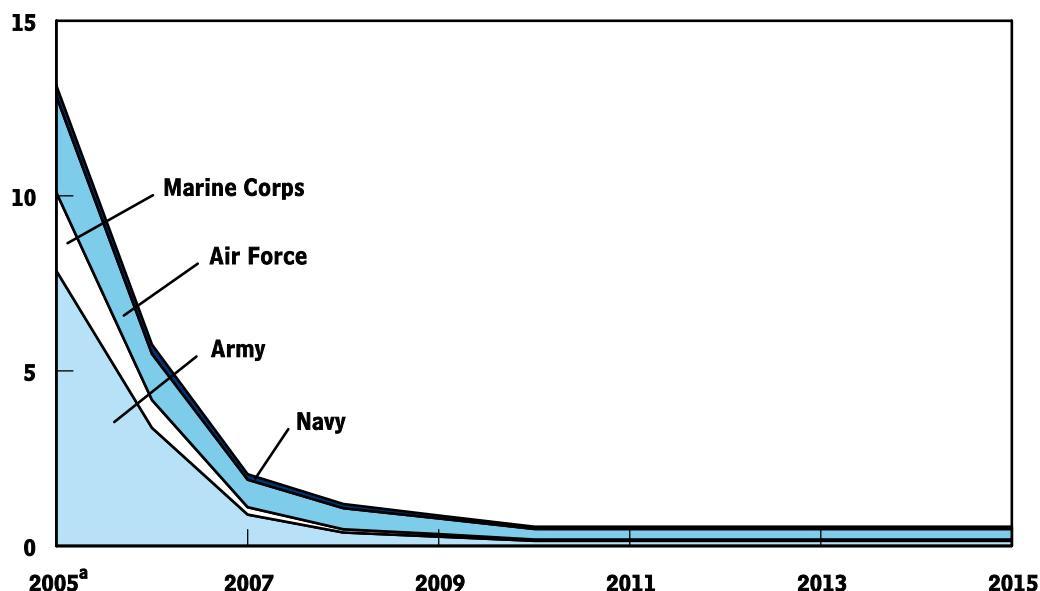
Service Estimates of Funding Required to Address Equipment Stress

In response to direction from the Secretary of Defense, the services estimated the resources they would need to address the effects of increased use of their equipment to conduct the war on terrorism. As directed, each of the services determined the resources they needed to repair and replace stressed equipment as well as to make necessary improvements (such as providing aircraft with equipment to counter surface-to-air missiles and trucks with additional armor). Further, they identified the investments needed to increase their repair and maintenance capability in the Iraqi and

Figure 6.

Annual Funds Needed to Maintain and Replace Equipment Used in Contingency Operations, Based on CBO's Bottom-Up Analysis

(Billions of dollars)



Source: Congressional Budget Office.

a. Includes backlog of unfunded requirements from 2003 and 2004.

Afghani theaters. The services provided CBO with the results of their equipment-stress analyses (see Table 12). As with CBO's analysis, the Army's requirements are significantly larger than those of the other services.

DoD's 2005 supplemental funding request for Operation Iraqi Freedom and Operation Enduring Freedom included funds to cover most of the services' requirements.²⁸ The supplemental funding request seeks approximately \$12 billion to "recapitalize equipment, conduct depot maintenance, and procure new and replacement equipment," according to the "Overview of Requirements" submitted with the request.²⁹ That number corresponds with the total amount—\$12.8 billion—that CBO compiled from service estimates of their unpaid costs through 2005 that are summarized in Table 12. According to information provided by the services in briefings, \$900 million of the \$12 billion included in the supplemental funding request would go to the Air Force to meet its requirements. Based on the Army's briefing, roughly \$6.5 bil-

28. DoD's request also included funds for Operation United Assistance, which provided relief to the victims of the tsunami in Southeast Asia.

29. In contrast, DoD's talking points state that the supplemental funding request included only \$8.7 billion for "depot maintenance and to replace worn-out/damaged equipment."

Table 12.

**Service Estimates of Unpaid Costs Accrued Through 2005
to Replace and Refurbish Equipment Used in the War on
Terrorism Since 2003**

(Billions of dollars)

	Repair	Replace	Improve Equipment	Increase In-Theater Repair and Maintenance Capabilities ^a	Total
Army	7.0	0.7	0	1.6	9.2
Marine Corps	0.4	0.3	0.3	0.7	1.7
Air Force	0.4	0.1	0.5	0	0.9
Navy	0.6	0.2	0.1	b	1.0
Navy aviation	0.1	0.2	0.1	b	0.4
Total	8.4	1.3	0.9	2.3	12.8

Source: Congressional Budget Office based on briefings from the services.

a. Referred to as "sustainment" in service briefings.

b. Less than \$50 million.

lion—\$3.4 billion for depot and other maintenance and \$3.1 billion to recapitalize and replace equipment—is included in the supplemental request to meet its equipment needs. That would leave approximately \$4.6 billion out of the \$12 billion that is included in the supplemental request to address equipment needs but that CBO could not attribute to a specific service or activity. Those funds would be sufficient, however, to cover most of the remaining unpaid costs attributable to the Army, Navy, and Marine Corps that CBO identified on the basis of the services' estimates.

Comparison of CBO's Estimates and Those of the Services

Although CBO used two very different methods to determine the costs associated with equipment stress, the resulting estimates are generally similar. And where CBO's estimates do vary from those derived by the services, they share some common features.

How CBO's Estimates Differ from Each Other

CBO used two approaches to estimate the costs related to equipment stress to provide the broadest possible insight into and perspective on those potential costs. The two methods, one taking an aggregate top-down approach and the other a more detailed bottom-up approach examining the effect on many individual systems, yielded roughly comparable results (see Table 13). Those results held true even though the

Table 13.

CBO's Estimates of Costs for 2005 and Total Unpaid Costs Accrued Through 2005 Related to Equipment Stress and Loss

(Billions of dollars)

	Top-Down Depreciation Method		Bottom-Up Maintenance-Activity Method ^a	
	2005 Only	Accrued Through 2005	2005 Only	Accrued Through 2005
Army	5.3	11.6	4.5	7.9
Marine Corps	1.1	2.7	1.1	2.2
Air Force	1.8 ^b	3.9 ^b	1.5	2.8
Navy	n.a.	n.a.	0.3	0.3
Navy aviation	0.2	0.2	0.1	0.1
Total	8.4	18.4	7.4	13.2

Source: Congressional Budget Office.

Note: n.a. = not applicable.

a. Based on midpoint of range of estimates.

b. Average of estimates based on aircraft lifetime of 30 years to 40 years.

approaches differed widely in the assumptions and methods used (see Table 14). In the top-down or depreciation approach, increased usage is assumed to shorten the useful lifetime of particular classes of equipment; maintenance costs are ignored or assumed to be implicitly included in the increased depreciation cost; entire classes of Army equipment—such as trucks or helicopters—are treated as one entity; and the total cost to each service is the sum of the costs of increased depreciation of each class of equipment. The estimates that result from that method exclude the costs of day-to-day maintenance activities, referred to as sustainment, and other relatively routine maintenance activities.³⁰ Rather, CBO's estimates based on that method correspond most closely to costs associated with activities that are relatively infrequent and more costly than day-to-day or scheduled maintenance activities, such as major overhauls, recapitalization, or replacement.

In contrast, the bottom-up or maintenance-activity approach was based on a detailed analysis of four types of maintenance activity plus replacement. In that method, each type or model of equipment—such as the M1A1 tank—was analyzed individually, and the lifetime of those pieces of equipment was not affected by increased usage. The

30. CBO's top-down approach also excluded costs associated with wear and tear on Navy ships and submarines that were included in the bottom-up approach.

Table 14.

Comparison of CBO's Approaches to Estimating Costs Associated with Equipment Stress

	Depreciation	Maintenance Activity
Unit of Analysis for Army Equipment	Class of equipment (such as Army trucks)	Individual equipment type or model (such as M1A1 tank)
Equipment Lifetime	Assumed to be reduced because of increased usage	Assumed to not be affected by usage
Maintenance Costs	Ignored or assumed to be implicit in increased depreciation	Increased costs because of higher operating tempo estimated explicitly for five types of activity for each type of equipment
Total Annual Cost	Sum of increased depreciation for all classes of equipment	Sum of cost increases for five types of maintenance and replacement activities

Source: Congressional Budget Office.

increased costs of each of the four maintenance activities and replacement were calculated separately for each type of equipment, and the total cost to each service was the increase in the costs for maintenance activities and replacement needed for those pieces of equipment whose usage increased appreciably over that in peacetime because of the war on terrorism. Because the bottom-up method included costs of routine maintenance, it is more comprehensive in its scope of types of costs examined than the first method. (Routine maintenance costs were not addressed in the top-down approach.) However, because the more detailed bottom-up approach was limited in the number of systems that it could examine because of data and time constraints, it may exclude the costs incurred by some systems that are being used at high rates in the war on terrorism and that were included in the more aggregate top-down approach. Thus, because each of the two methods includes costs that are not contained in the other method, there are some differences between the two that cannot be totally reconciled. But they do provide different perspectives on and illuminate different aspects of the costs of increased equipment use by the military in the war on terrorism.

How CBO's Estimates Differ from Those of the Services

In addition to differing from each other, CBO's two estimates also differ from those of the services. Neither of CBO's estimates includes the following costs because they are not a direct consequence of increased equipment usage:

- The cost of improving equipment that is currently used in the war on terrorism (for example, aircraft survivability equipment or armor for trucks);

- The cost of reorganizing the Army's force structure, often referred to as "modularity";
- The cost of establishing repair and maintenance facilities, and improving those that exist, in the Iraqi and Afghani theaters (referred to as improving "sustainment capability" in service estimates);
- The cost to replace many small items such as tents, pallets, and expended munitions such as Hellfire missiles; and
- The cost to upgrade or modernize systems when they are replaced (for example, replacing an A2 version of the Bradley fighting vehicle with an A3 version).

CBO also was unable to include the effect of the harsh desert and operating conditions on equipment in the Iraqi or Afghani theaters in either of its estimates because those effects have not been quantified. Finally, CBO did not include the costs associated with Air Force and Navy ground equipment because those costs are small relative to other categories of cost included in CBO's estimates.

Although both of CBO's estimates differ from the services' estimates by excluding those costs, each differs from the services' estimates in unique ways.

Differences Between CBO's Top-Down Estimate and Those of the Services. CBO's top-down estimate, which is based on the increased rate at which the services would need to replace all of their equipment used in the war on terrorism because of increased wear and depreciation, could result in an overestimate compared with the services' estimate for two reasons. First, with respect to the Army, the top-down approach aggregated equipment used in the war on terrorism into very broad categories and assumed that all equipment in-theater experienced elevated usage rates compared with peacetime. It also assumed that all equipment in a given class experienced the same elevated usage rate. That may be an overstatement of the Army's equipment-related costs because certain types of equipment may not be experiencing conditions that would necessitate their replacement. Second, because CBO assumed that a piece of equipment reaching the end of its useful lifetime would be replaced immediately, the resulting cost estimate represents an upper limit on the replacement costs for a given year. In other words, equipment reaching the end of its useful life would not necessarily need to be retired and replaced immediately—as CBO assumed—particularly if the services have additional equipment, such as that assigned to units not engaged in the war on terrorism, that could be used in-theater.

Conversely, some of CBO's assumptions made as part of the top-down approach may result in an estimate that would be lower than that of the services. As mentioned previously, CBO did not take into account any increased wear and tear—above that attributable to higher OPTEMPO—that would result from harsh desert conditions or greater-than-peacetime loads that equipment might be experiencing in Iraq and

Afghanistan. In addition, CBO did not take into account differences in cost that would result because some types of equipment are no longer being manufactured and therefore cannot be replaced by brand-new copies of exactly the same equipment. (The Army's OH-58D helicopter and 939 series of medium trucks are examples of pieces of equipment that are being used heavily in the Iraqi theater but are no longer being bought by the Army or produced.) In such instances, if the worn-out pieces of equipment were to be replaced, the services would have to replace them with equipment available from an existing production line. In some cases in which CBO's estimate includes funds to replace various types of equipment, the services would have to buy a more modern—and generally more expensive—version. And in other cases, such as Army reconnaissance helicopters and Air Force tankers, the service will not replace worn or damaged equipment until production of its next-generation systems begins.³¹

Differences Between CBO's Bottom-Up Estimate and Those of the Services. CBO's estimates derived from the bottom-up approach also differed in several ways from the services' estimates of costs related to equipment stress. First, CBO's estimates include sustainment costs associated with higher operating tempos; those costs might be defined as operating costs in the services' estimates rather than as costs associated with equipment stress. Second, as with its top-down estimate, CBO's bottom-up estimate did not take into account additional stress and related costs that might result from equipment operating in the harsh environments of Iraq and Afghanistan. Anecdotes suggest that dusty, sandy, and hot surroundings wear down equipment at a higher rate than a more temperate operating environment. Third, CBO assumed that the services' ability to maintain and replace equipment was unconstrained. In other words, CBO did not consider manpower limitations or maintenance-facility capacities in its estimates.

The bottom-up approach relies on the premise that increased equipment use generates an increased need for maintenance, repair, and replacement. CBO assumed that, for each system, the costs of maintenance and repair activities increase with equipment use at a constant rate. However, if those costs do not grow in strict proportion to equipment use, then actual costs may differ from CBO's estimates.

31. Excluding the costs to replace Army OH-58D reconnaissance helicopters would decrease the Army's estimated requirement by roughly \$55 million in 2005. Forgoing replacement of Air Force tankers would lower the 2005 estimate by \$380 million to \$500 million.